Application Note: AZD041
IQ Switch® - ProxSense™ Series
IQS128 Design Guide for On Ear Detection for Mobile Phones

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1 Introduction

This document provides details on sense plate design and detection thresholds for using the IQS128 for "On-Ear detection" in mobile phones. The full datasheet is available at www.azoteq.com. The following table highlights the advantages that the IQS128 adds to mobile handsets:

Feature	Description	Benefit
Auto Screen or Key backlighting	Automatic shut-off of displays when no longer needed	Improved power efficiency for extended battery life
No False key detections	Disabling of keypad when in call and phone is close to ear	Improved performance
Auto call-answering	Answer call by placing earpiece close to ear	Added convenience
Auto speaker or Bluetooth hands free	Switch between loud speaker and earpiece mode	Added convenience
Volume adjustment	Adjust volume of device's by measuring distance to user	Improved ease-of-use
Capacitive Sensor	No change to handset housing	Improved aesthetics
Cost Reduction	Lower cost compared to IR	Reduced BOM cost
Power Reduction	Lower power consumption compared to IR	Increased battery life

2 Mechanical Considerations

There are two important aspects surrounding the design of the sense plate:

- Geometry (size, shape and position)
- Shielding/Directivity

2.1 Geometry

The size, shape and position of the sense electrode are largely dependent on the handset used. Typically the sensing area (position) for on ear detection is around the speaker, at the top of the mobile phone, as indicated in Figure 2.1.

Figure 2.1 Sense Area.

The sense plate is made as large as the cover allows, leaving room for shielding (as discussed in the next section). The shape of the sense plate is determined by the handset design, and can be formed around the speaker, but not too close to the screen.

Conductive tape (copper tape) works well for prototyping, while flexible PCBs (FPC) is suggested for mass production.

2.2 Shielding

For touch screen phones, it is preferred not to have the sensing area too close to the screen, to avoid false triggers when a user finger is operating the screen.

Avoid having the sensing area around the edges of the phone, to prevent a trigger from the user hand while holding the handset in various positions.

As with all capacitive sensing, the IQS128 senses omnidirectional. Ground planes can be implemented to make the antenna directional.

Figure 2.2 shows how ground planes are implemented to achieve the above mentioned shielding.

Figure 2.2 Position of the sense electrode around the speaker – Also showing the ground planes for shielding[1].

As space in mobile handsets is often limited, the general rule for spacing between the ground (shielding) and the sense plate is 3mm, to avoid the sense plate to be too desensitized.

3 Settings

3.1 Miscellaneous

- Active High – This is the fastest for prototyping, using a LED indicator. Remember that in active low and streaming mode, the output pin of the IQS128 is SW open drain, and needs to be pulled to the supply (10k).
- RF Noise Detect = Enabled – to avoid false triggers during calls.
- Thalt = 3sec – This ensures that device returns to normal (after 3sec) when only a proximity condition is detected.

3.2 The Prox Threshold

The proximity threshold will differ for different designs and layouts. The Prox threshold should be sensitive enough to achieve the required sensing distance (mostly 2cm for on ear detection applications), keeping in mind that the ground shielding will desensitise the device. The Prox threshold should also be high

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[1] Depending on the size and layout of the handset, the sense plate could also be placed below the speaker. This will optimize layout, as the speaker could be used as the top ground shielding.

enough to avoid false triggers. For most applications, a Prox threshold of 4 (default) is a good starting point for prototyping.

3.3 The Touch Threshold

The Touch threshold should be low enough to ensure a touch condition is detected when the user uses the mobile in conversation (allows the filter to halt). The touch threshold should also be high enough (see Section 1) to avoid a reset in touch mode when the user moves the handset away slightly (as with normal operation, the mobile does not stay the same distance from the user ear during conversations).

For most applications, a Touch threshold of 200 is a good starting point for prototyping.

3.4 Standby Mode

The IQS128 can be used in a low current (7uA) standby mode by halting the conversions until events such as incoming calls occur. The halt charge is implemented with the CTRL pin:

If CTRL is sampled high for longer than T_{EXT_HALT}, the charge conversion cycle will be halted. An automatic reseed is performed directly after CTRL is released to compensate for any environmental changes which might have occurred during the standby mode.

In practice, the IC can be halted (7uA) while the phone is in standby. Sensing (70uA) is only required when a call is made or answered.

3.5 Reseed

To avoid stuck conditions, a reseed condition can be initiated by generating a pulse on the CTRL pin. The LTA will be reset to the current sample, forcing the OUT pin to its original state. The pulse on the CTRL pin needs to adhere to the following timing constraints: 25ms < T_{RESEED} < 35ms

If the current sample value is outside its allowable limits, the device will force an ATI event to reset the system sensitivity.

4 Example FPC

Flexible PCBs are an easy way to integrate the IQS128 into mobile phones. FPC is already in use in mobile phones, to connect the screen to the main PCB (especially slide phones). FPC could also be used for the sense plate and ground/shielding as shown in Figure 4.1.

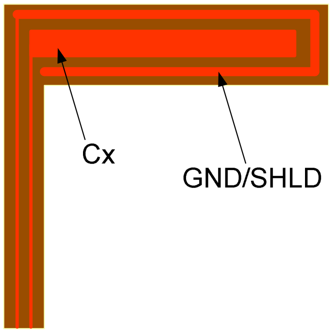

Figure 4.1 FPC for sense electrode.

Depending on size constraints of the handset, FPC can be used to position the IC, as illustrated in Figure 4.2.

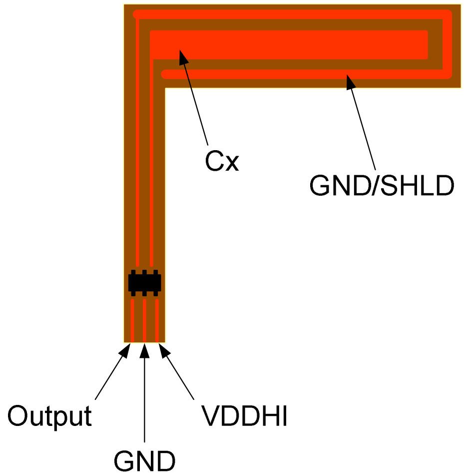

Figure 4.2 FPC with sensor and electrodes.

5 Reference Design

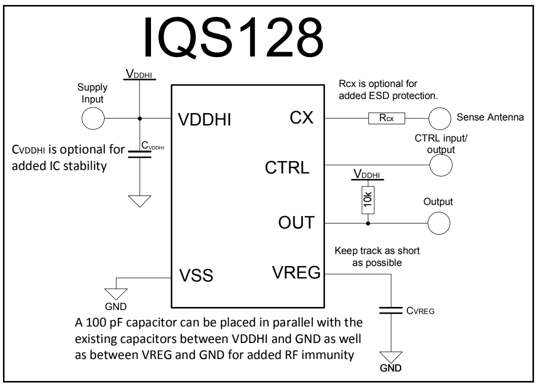

Figure 5.1 IQS128 Reference Design.

6 DYCAL™ Operation

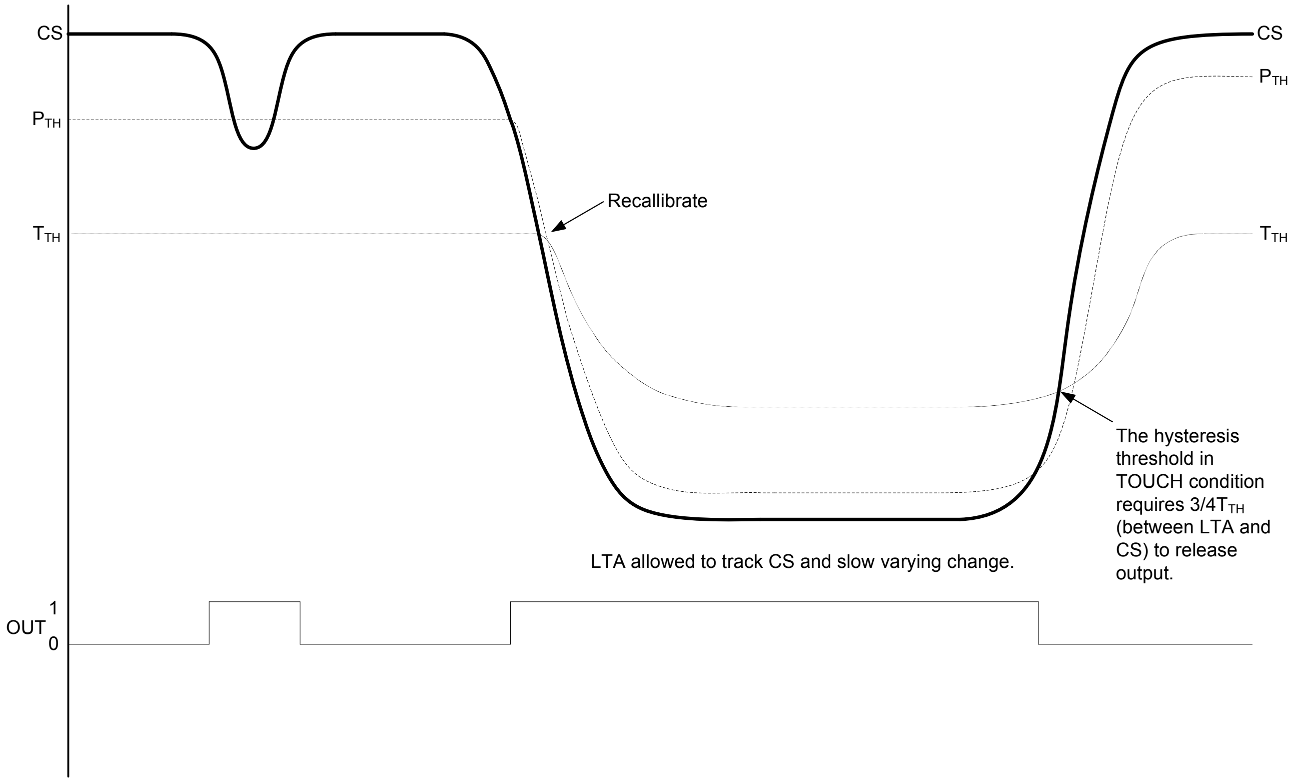

Figure 6.1 DYCAL Operation.

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